ANTI-SABOTAGE AND ANTI-THEFT DEVICE FOR TIRE INFLATING VALVES

Background of Invention

Field of the Invention

The invention relates generally to tire valves.

Background of the Invention

Most modern terrain and aircraft vehicles use gas-inflated tires with or without an inner tube. For these tires to function properly, they have to contain a pre-established gas quantity (usually air, but sometimes other gases). The gas in a tire must reach and maintain a prefixed pressure value at a given temperature reference. However, when a tire is inflated by introducing a specific gas quantity, that quantity decreases because of natural gas leaks from the tire and other components of the wheel the tire is part of. Gas loss may also occur because of accidental leaks due to damage and/or punctures. Moreover, the right quantity of gas to be introduced into the tire also depend on the specifications of the vehicles on which the tires are mounted, on the expected use conditions, and on the load and speed of the vehicle. Therefore, interventions are necessary in order to modify or to restore the right quantity of gas inside the tires.

Summary of Invention

In some aspects the invention comprises: a cap with an internally threaded body which screws onto the inflating valve of a tire; an envelope connected to the internally threaded body, use of a free tripper allowing the screwing only and not the unscrewing of the cap, the envelope preventing direct access to the threaded body, the access occurring only in a pre-established zone of the threaded body, while the unscrewing of the threading body occurring through a tool acting on said zone. In a first embodiment the free tripper presents a radial development. In a second embodiment the free tripper presents an axial

development.

An element is provided between the threaded body and the threaded end of the tube of the valve; the element generates an unscrewing force, which is higher than the one due to the clamping of the threaded body on the tube only. In order to obtain the unscrewing of the cap, an undercut tool is used to reach the pre-established zone of the threaded body; the tool engaging teeth found on a lower appendix of the threaded body. The undercut tool is fitted with own teeth shaped to apply an unscrewing force only and not a screwing one.

The pre-established accessing zone to the threaded body for the unscrewing, engaged by a tool, is located on the upper part of the threaded body and it is reached through a passage in the envelope. The engaging zone of the external contour of the envelope presents knurls, grooved or polygonal profl1es for an efficient transmission of the screwing torque. A sliding pair is provided, said sliding pair being formed by a radial protuberance and a corresponding groove located in the internal wall of the envelope, the sliding pair allowing the transmission of the torque in both directions between the envelope and a cylindrical member, and allowing the cylindrical member to freely axially translate inside an internal housing located between the threaded body and the envelope. A spring is further provided to keep the frontal teeth of the axial free tripper engaged.

The axial free tripper comprises teeth integral with the threaded body and teeth integral with the cylindrical member; the shape of the teeth is chosen to allow the transmission of a sufficient screwing force and a negligible unscrewing force between the envelope and the threaded body. The radial free tripper comprises teeth integral with the threaded body and radially deforming teeth integral with the envelope; the shape of the teeth is chosen to allow the transmission of a sufficient screwing force and a negligible unscrewing force between the envelope and the threaded body. The contact between teeth, integral with the threaded body and teeth, integral with the envelope, occurs on contact surfaces inclining of an angle (γ, δ) in order to disengage the contact between teeth and teeth, so that the screwing force transmitted by the envelope to the body is

limited.

Brief Description of Drawings

Figure 1 illustrates a prior art cap on the end of a tire valve and valve assembly.

Figure 2 illustrates a prior art valve for a tubeless tire.

Figure 3 illustrates prior art covers used on tubeless tire valves.

Figure 4 illustrates a prior art cap on the end of a tire valve and valve assembly.

Figure 5 illustrates an embodiment of the present invention.

Figure 6 illustrates an embodiment of the present invention.

Figure 7 illustrates a preferred embodiment of the present invention with a free tripper in a radial shape.

Figure 8 illustrates a preferred embodiment of the present invention with a free tripper in an axial shape.

Figure 9 illustrates an alternative embodiment of the present invention.

Figure 10 illustrates an alternative embodiment of the present invention.

Figure 11 illustrates a removal tool to be used with one embodiment of the present invention.

Figure 12 is a detail illustration of a removal tool to be used with one embodiment of the present invention.

Figure 13 illustrates an alternative embodiment of the present invention.

Figure 14 illustrates an alternative embodiment of the present invention.

Figure 15 illustrates an alternative embodiment of the present invention with a device to limit the screwing torque.

Figure 16 illustrates an alternative embodiment of the present invention with an alternative device to limit the screwing torque.

Figure 17 illustrates an alternative embodiment of the present invention with an alternative device to limit the screwing torque.

Description of Prior Art

To provide the ability to modify the gas quantity inside a tire, a valve is usually fixed to the tread of the tire (in the case of tires with an inner tube, the valve is affixed to the inner tube and transverses the tire tread through a hole).

Said prior art valve is shown in Fig 1. This typical valve has a metal tube 1 containing a body 2 fixed to its inner part through a sealed threaded connection 3, in which a self-closing member 4 with a sealing gasket 5 axially slides, said closing member 4 being held in the closed position by a spring 6. The closing member 4 is capable of automatically opening when pressure on its top face located in chamber 7, sufficiently exceeds counter pressure caused by the force of the spring 6 and the pressure inside the tire and in chamber 8. The self-closing member 4 can also be opened by a mechanical action by applying a force on its top face towards the internal part of member 4.

In the fixing of the valve to the wheel group, that is to the tread, in case of a tire with the tube, the metal tube 1 is let into a rubber protuberance connected to a hole in the tube of the tire. The protuberance is then inserted in its own hole in the tread.

In the case of tubeless tires, the metal tube 1 is properly shaped and threaded, as shown in Fig 2, in its lower part in order to get a direct connection (with use of gaskets) to a hole in the wheel tread (not shown). The threading allows for the fixing of the valve though the use of a nut, which is connected to the hole of the tire tread by the use of a rubber covering (Fig 3) applied to the metal tube 1 and then suitably shaped and fitted with a groove having a suitable diameter (B), and with an abutment of diameter (A) capable of assuring the fixing of the valve by the gas pressure inside the tire.

The end of the metal tube 1 which is outside of the tire is externally threaded 9. This allows for both the affixing of devices for inflating the tire and for affixing a capping device ("cap") 10 which closes and/or protects the valve., The cap is further prevents direct access to the self-closing member 4, and protecting said the self closing member 4

(and other parts) from impacts and/or the introduction of pollutants (dirt, dust, etc) which could cause damage or malfunction of the valve.

Another prior art cap is shown in Figure 4. Figure 4 shows a cap with a gasket 11 for clamping the end of the metal tube. The gasket 11 provides additional sealing protection against any gas leak through the valve when its internal members cannot assure a perfect sealing.

Some prior art caps are known to include devises for measuring and/or monitoring the functioning condition of the tires (for example, by means of the measuring of the inflating pressure, temperature, etc.) and signaling that condition outside. For example, the cap disclosed in EP No. 0 893 284 belonging to the Applicant.

Tire valve caps, must also assure they can be mounted on the valve and the dismounted from the same valve (for example for the usual tire inflating) repeatedly.

The prior art valves, do not provide any appropriate means to prevent the usual unscrewing and removal of the cap. Therefore, prior art caps are screwed to the valve (by hand or by proper tools) and, consequently, are easily unscrewed (by hand or by tools). On the wheels of certain land and aircraft vehicles with tires, anti-sabotage and anti-theft functions are desired.

The anti-theft function can be considered as a subset, or a consequence, of the anti-sabotage function, in particular when the cap consists of a more complex device capable of carrying out other functions (for example, measuring and monitoring the functioning conditions of the tire).

Both in case of usual protecting caps of the tire valves and in case of more complicated devices applied on the valves instead of the usual protecting cap, the theft does not cause the loss of an economical value only but, the loss of the cap also causes the risk of

contamination and possible dangerous external actions for the valve body, and in particular for the self-closing member 4. In any case, the theft causes inconvenience, trouble, and annoyance for the owner and/or driver of the vehicle. Therefore, the anti-theft function for these caps is suggested both for simple protecting caps as well as the more complicated caps which measure and monitors the tire's conditions.

Additionally, the removal of the protecting cap of the valve is often carried out not only to take possession of the cap, but also to access to the self-closing member 4, opening of the valve and allowing the leakage of gas from the tire. This can lead to the intentional total or partial deflating by someone, of one or more tires. It is very difficult to see a partial and unexpected deflating when getting in a vehicle or driving it at low speed, but the consequence can be fatal because of the decline of the driving and safety conditions for the vehicle as higher speeds are obtained. It is, therefore, useful and important to prevent such a situation and permit only authorized access to the valve or to removal of the cap.

The aim of the invention is to remedy these failures of the prior art.

Detailed Description of Invention

The disclosed technology solves the problems of the prior art by preventing the undue or unwanted removing of the cap 10. This provides the cap with the desired anti-sabotage and anti-theft functions without modifying the structure of the valve, or the usual mounting or uses of the cap; The disclosed technology further provides a cap with a device for controlling of the clamping torque.

As shown in Figs 5, 6, the disclosed technology has multiple embodiments. One embodiment is shown in Fig. 5., the metal tube 1 has an undercut shaped contour 12 instead of the usual threading so that the clamping cap 10 radially embraces one of its parts 13 around the undercut shaped contour 12. Another embodiment is shown in Fig. 6,

in this embodiment, the threading 9 is kept but a further radial clamping member 14 (such as a clamp, radial screw, etc.) is used on the cap 10. The member 14 requires a particular tool to be used to remove the cap 10.

In the preferred embodiment, it is not necessary to modify the usual tire inflating valve. Further in the preferred embodiment, use of the disclosed devise does not interfere with devices that measure and/or monitor the tire's conditions. Further, the starting of the anti-sabotage-anti-theft functions are as normally obtained as for the screwing and clamping of a usual protecting cap, by hand, without particular tools or keys.

The preferred embodiment attains the anti-sabotage and anti-theft functions without modifying the usual mounting and clamping of the cap 10 and without changing the standard inflating valve of the tire. In the preferred embodiment the means for removal of the disclosed device is not obvious or based on generic tools. Further, in the preferred embodiment removal does not requires the permanent change or destruction of the disclosed device. It can therefore be used and reused.

Fig. 7 is an illustration of the preferred embodiment. The cap is normally screwed by applying the proper torque to the cap envelope 16 (usually this operation is carried out by hand, therefore the torque is never very high. Also, the small diameter of the envelope limits the torque). When the cap is completely threaded it is no longer removable if a particular tool, mechanism, or key is not used. In the preferred embodiment the cap has at least two main members: an internally threaded member 15 capable of screwing on the end of the valve 9 and the envelope 16 of the cap. The internally threaded member 15 is engaged though a free tripper allowing the transmission of a torque between the envelope 16 and the threaded member 15 in the screwing direction only. When the clamping of the cap is reached and a proper stopping torque is achieved, it is impossible to unscrew the cap from the valve since the unscrewing action applied to the envelope 16 is not transmitted to the threaded member 15.

In order to remove the cap it is necessary to provide parts on the threaded member 15; said parts being properly shaped and capable of clamping by means of a special key, or tool. These removal parts are located in a zone of the cap/valve group not directly accessible, so that unscrewing by means of improper tools is prevented. Additionally, through a gasket 11, a further barrier to gas leakage is created.

The function preventing the manual unscrewing of the cap after its screwing on the tire inflating valve is obtained by separating the envelope 16 from the internally threaded member 15 and by introducing between them an unidirectional free tripper. Said unidirectional free tripper can have a radial shape as is shown in Fig 7 Section A-A, or an axial shape, shown in Fig 8.

According to a preferred embodiment of a free tripper in the radial shape, radial teeth 17 are found on the external cylindrical surface of the threaded body 15, the teeth 17 being capable of engaging the frontal surface of proper protuberances 18 connected to the internal cylindrical surface of the envelope 16. Said protuberances 18 are normally located in the configuration of Fig 7 Section A-A, but they present elasticity sufficient to allow their radial flex towards outside so that they disengage, eventually, from the teeth 17. The radial elasticity of the protuberances 18 is eventually controlled or changed by means of external elastic members, such as springs, polymeric members, etc.

By applying a torque in a clockwise direction (according to Fig 7 Section A-A) to the envelope 16, the protuberances 18 engage the teeth 17 and transmit the torque to the threaded body 15. Vice-versa, by applying a torque in a counter-clockwise direction (according to Fig 7 Section A-A) to the envelope 16, the protuberances 18 slide on the back of the teeth 17 and they do not transmit any torque to the threaded body 15 (a minimum value due to the friction during the sliding of the protuberances 18 on the back of the teeth 17 excepted).

According to a preferred embodiment of a free tripper in the axial scheme, shown in Fig 8, frontal teeth 19, parallel to the axis of the device and located on an external circumference of the threaded body 15, engage the homologous axial frontal teeth 20 located on a cylindrical member 21 to be co-axially mounted on the threaded body 15 and capable of axially sliding downwards with respect to the body 15. The sliding has a sufficient width to disengage the homologous teeth, while a spring 22 pushes on the cylindrical member 21 upwards, which tends to maintain the teeth 19, 20 in contact with each other. For mounting reasons of the cylindrical member 21, the threaded body 15 consists of two parts 15a, 15b welded to each other (in other embodiments this is made as a single piece).

The cylindrical member 21 is connected through a sliding pair, for example the radial protuberance 23, to a corresponding groove 24 located in the internal wall of the envelope 16; so doing, it is possible to transmit a torque in both directions between the envelope 16 and the cylindrical member 21, which, carries out its axial translation in the housing located inside the external cylindrical surface of the threaded body 15 by contrasting the action of the spring 22. By applying a torque in the screwing direction on the envelope 16 said torque is transmitted to the cylindrical member 21, its axial teeth 20 engage the homologous axial teeth 19 of the threaded body 15. In this way, the stopping torque is transmitted to the threaded body 15.

After the clamping, a non-return force acts between the threaded body 15 and the threaded end 9 of the tube 1 of the tire-inflating valve. Applying a torque in the unscrewing direction on the envelope 16, said torque is transmitted to the cylindrical member 21, its axial teeth 20 tend to slide on the homologous back of the axial teeth 19 of the threaded body 15; this is due to the particular inclination angle of the backs of the teeth, so that the cylindrical member 21 tends to downward translate against the force of the spring 22, without transmitting an unscrewing force to the threaded body 15.(a value of the friction force in the sliding motion of the backs of the axial teeth excepted.)

An alternative embodiment is shown in Fig. 9. In Fig. 9, the spring 22 is located between the threaded body 15 and the envelope 16: in this case, said spring 22 acts as above, if the sliding pair between the envelope 16 and the cylindrical member 21 presents an axial abutment compelling the cylindrical member 21 to move downwards the envelope 16 against the force of the spring 22, if the unscrewing force is applied to the envelope 16 and the teeth backs of the cylindrical member 21 slide with respect to the ones of the threaded body 15.

With this configuration, it is possible to make the envelope 16 and the cylindrical member 21 in one piece or make them connected with each other. By using these mechanisms, only a part of the torque in the screwing direction (in a clockwise direction in Fig 7 if a right thread is used) is transmitted to the threaded body 15 because of the friction between the free tripper teeth and the threaded body 15.

In both radial and axial embodiments, the mesh among the homologous teeth is replaced by homologous cavities on both parts with interposition of properly shaped floating connecting rods, as for free trippers of common industrial production.

The unscrewing of the device by acting on the external envelope 16 is prevented if the threaded body 15 is clamped, causing a non-return clamping force with a value higher than the torque that can be transmitted in the unscrewing direction, said torque being low but existing.

In order to assure a higher non-return clamping force, beyond the usual connection through the threads when their both ends are in contact, other members are used, for example and without limitation:

Self-clamping devices in the threaded body 15 on the male thread 9, as a partial deformation of the female thread of the threaded body 15 or the interposition, on its upper end, of a deforming element capable of causing an high friction force on the thread

9, as usually used for the self-clamping nuts. (See Filippi, Disegno di Macchine, Vol. II, Hoepli);

Further components allowing a strong friction and an effective non-return force between both parts 15, 19 fixed each other, as for example elastic washers of UNI 1751 e 1752 o DIN 128, undulated and knurled elastic washers, plane or conic elastic washers with toothing according to UNI 3703, 3704, 3705, 3706, etc (See Filippi as cited), to be applied to the abutment end of the male thread 9 in order to avoid damages of the male thread.

In an alternative embodiment shown in Fig 10: the upper abutment end of the male thread section 9 of the tube 1 of the inflating valve contemporaneously touches both the sealing gasket 11 and the element 25 characterized by elastic axial toothings engaging the seat found on the upper end of the cavity of the threaded body 15 and the abutment end of the tube during the clamping, causing a strong non-return force against the unscrewing.

To assure the unscrewing is carried out only when authorized it is necessary to apply the unscrewing force directly on the threaded body 15 in zones which are reachable only by means of proper tools and available only for buyer of components fitted with anti-theft devices.

For the embodiment shown in Fig 8, a proper tool is shown in Fig. 11. This embodiment using a special key 26 with two arms on the lower part 27 of the threaded body 15; the key 26 axially extended downwards so that proper radial notches 28, capable of introducing the teeth 29 of the special key 26, are formed. Said lower part 27 is covered by the external envelope 16 and is undercut with respect to the envelope 16. Only by means of a key capable of conforming to the undercut and engaging the notches 28 found on the lower part 27 of the threaded body 15, so that the required unscrewing force is applied to the threaded body 15, can the unscrewing of the valve cap be carried

out. Both arms 26a, 26b of the special key 26 are flexible or movable in the radial direction to open and allow reaching the lower part 27 of the threaded body 15.

The teeth 29 located at the ends of the arms 26a, 26b of the special key 26 are to engage the lower part 27 of the threaded body 15 and are shaped as shown in Fig 12. So that the key is used only for applying a unscrewing force to the threaded body 15, said teeth 29 present a sloping plane tending to extract them from the notch 28 if a screwing force is applied. This is useful to avoid the application of exceeding clamping forces.
An alternative embodiment to directly apply the unscrewing force to the threaded body 15 in zones which are reached only by means of proper special tools consists is shown in Fig 13. The external envelope 16 has a central opening 30 in the upper wall. Through said central opening 30 a blind hole 31, finding on a protuberance 32 located on the upper part of the threaded body 15, is reached. The protuberance has a proper and non standard contour where only a key with a male profile having the same area of the blind hole 31 is inserted for unscrewing. To prevent the introduction of impurities, the interference zone between the central opening 30 of the envelope 16 and the protuberance 32 is fitted with a proper gasket 33.

In all the described embodiments, in order to prevent the introduction of impurities, a further gasket or protecting lip 34 is provided in the lower part of the envelope 16 in its interface zone with the cylindrical lower part of the threaded body 15.

In all the above described embodiments, it is also possible to shape the external contour of the envelope 16 in the engaging zone for applying the force (both manual and by means knurls, grooved or polygonal contours as shown in Fig 14.

The clamping of the cap on the valve is correctly reached when it is obtained by means of a proper, sufficient and not excessive final force. Both in the case of manual screwing of the cap on the end of the tire inflating valve and, more importantly, in case of using of ancillary tools for a stronger clamping force, there is a risk of too strong of a clamping

force damaging the cap and/or the sealing gasket 11. But, the application of an excessive clamping force is not the only problem: also an insufficient clamping force is harmful since it invalidates the sealing gasket 11 action and causes the unexpected unscrewing of the cap because of vibrations from the operation of the vehicle.

Advantageously, the anti-sabotage and anti-theft device applied to the protecting cap of the tire valve is, fitted with members assuring an efficient and full clamping of the threaded elements 15, 9 and of the eventual gasket 11 located inside the cap for sealing on the upper edge of the threaded end 9 of the tire inflating valve by an unskilled person who lacks proper tools. In an alternative embodiment a signaling devise advises the operator when a screwing torque with a proper value is reached, this prevents an excessive clamping by applying excessive screwing torque. Because excessive clamping causes a quick deterioration of the cap a limiting device for the screwing torque (which is also capable of advising the operator if the required torque value is obtained) is desirable.

Fig. 15 illustrates an alternative embodiment of the disclosed technology with a device to limit the screwing torque applied by the external envelope 16 to the threaded body 15 through the free tripper. In Fig 15, the frontal part located between the teeth 17 and the protuberances 18 is so shaped that the frontal part is not radial, that is perpendicular to the force mutually transmitted each others (approximately tangential), but slanted with a proper angle γ with respect to the radial direction causing, during the contact between both surfaces A and B of the tooth 17 and the protuberance 18, a radial component R tending to bend the protuberance 18 towards outside in order to disengage it from the corresponding tooth on the threaded body 15.

When a pre-established perpendicular force F between the two surfaces A and B (that is when a pre-established torque value applied to the external envelope 16 is reached assuring the proper clamping of the threaded body 15 on the tube of the tire inflating valve), the radial component R reaches a value causing the disengaging of the two

surfaces A and B of the teeth of the free tripper. This limits the maximum clamping force to be applied and advises the operator through a quick decrease of the opposite force, together with a vibration and noise due to the radial release of the teeth, that the correct conclusion of the clamping operation has been reached. The force limiting member is easily regulated by properly planning the angle γ and the elastic reaction of the protuberances 18.

Fig 16 illustrates a force limiting member in a device with an axial free tripper. The force limiting member is made by a slant of δ degrees to the contacting surfaces of the frontal teeth 19, 20. Initially on planes parallel to the axis of the device, transmitting the torque between the external envelope 16 and the threaded body 15 through the cylindrical member 21: the same effect as described above for the radial free tripper is reached. In so doing frontal teeth 19, 20 are allowed a relative helical movement between the external envelope 16 and the threaded body 15. A contrasting elastic member (the spring 22 of Fig 9), properly loaded acts to prevent the axial movement of the cylindrical member 21 and/or the external envelope 16 with respect to the threaded body 15. The helical movement, and the relevant axial descent of the cylindrical member 21 and/or the external envelope 16 with respect to the threaded body 15, begins only after the screwing force applied to the external envelope 16 has exceeded a value capable of generating, in the helical coupling of the frontal cams 19, 20, an axial force higher than the one due to the contrasting elastic member 22.

When this force value has been exceeded, the relative sliding of the helical surfaces E and G of the frontal cams 19, 20 and the descent, for a stroke C, of the cylindrical member 21 and/or the external envelope 16 with respect to the threaded body 15, at the end of which the cylindrical member 21 and/or the external envelope 16, due to the force of the contrasting elastic element 22, releases again upwards until the surface G of the connected frontal cam is in contact with the surface E' of the immediately following tooth located on the threaded body 15. In this way a second kind of axial free tripper is obtained which, in conjunction with the force of the contrasting elastic element 22, forms

a force limiting device capable of being easily adjusted by properly planning the angle δ and the contrasting force of the spring 22.

By applying a force to the external envelope 16 higher than the one necessary to exceed the maximum torque to be applied to the threaded body 15 and the reaction of the elastic element 22, an axial force P positive in the direction shown in Fig 17 is reached. This force P with stroke C is due to the helical coupling of the surfaces E and G of the frontal cams 25.

In other embodiments of the disclosed device the force limiting member provides that the relative sliding between the helical surfaces E and G of the two frontal cams, which are respectively found on the threaded body 15 and the external envelope 16, is limited to just one stroke C' (Fig 16) lower than the stroke C causing them to disengage and preventing the surface G from the contact with the surface E to the contact with the surface E' after passing said stroke C. When the pre-established value of the clamping force of the threaded body 15 on the valve end is exceeded, a direct helical movement of the external envelope 16 with respect to the threaded body 15 occurs; said movement causes a translation of the external envelope 16 with respect to the threaded body 15 for a quantity corresponding to C'. When the clamping force applied to the external envelope 16 releases, it causes the return of the external envelope 16 to its resting position with respect to the threaded body 15, by means of a retrograde helical motion due to the reaction of the elastic element 22.

In each embodiment the disclosed technology can be used in replacement of usual protection caps and can also be used in conjunction with those devices for controlling, measuring or monitoring the functioning condition of tires which are screwed on the external end of the inflating valve.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the

invention as disclosed here. Accordingly, the scope of the invention should be limited only by the attached claims.

ANTI-SABOTAGE AND ANTI-THEFT DEVICE FOR TIRE INFLATING VALVES

Abstract

An anti-sabotage and anti-theft device for tire inflating valves has been developed. The device includes an internally threaded member that is capable of screwing onto and off of an inflating valve of a tire, a cap envelope shaped to prevent access to the internally threaded member without a specialized tool; and a free tripper member that connects the cap envelope the internally threaded member. The free tripper allows for the unidirectional screwing of the entire cap assembly by hand.